DEVONIAN CORALS AND BRACHIOPODS FROM THE BRENDON HILLS, WEST SOMERSET

by B. D. WEBBY

ABSTRACT. The coral and brachiopod faunas of the Middle–Upper Devonian Ilfracombe Beds in the Brendon Hills, west Somerset, have been examined. The corals are restricted to two limestone horizons in the Ilfracombe Beds, the Rodhuish Limestone and the Roadwater Limestone; the brachiopods are sparse and more uniformly distributed throughout the succession. The rugose corals, *Heteroplirentis percevali* sp. nov., *Thamnophyllum caespitosum* (Goldfuss), *Acanthophyllum* (*Neostringophyllum*) *concavum* (Walther) and *Mesophyllum* (*Arcophyllum*) *sandlullense* sp. nov.; a tabulate coral, *Thamnopora polyforata* (Schlotheim); and two brachiopods, *Spinocyrtia ascendens* (Spriestersbach) and *Thomasaria gibbosa* Vandercammen, are described. The coral and brachiopod faunas suggest that the bulk of the Ilfracombe Beds is Givetian; the Upper Hangman Grits and the lower part of the Ilfracombe Beds (the Avill Group) are Lower–Middle Givetian; the Cutcombe Slate and Rodhuish Limestone are Middle–Upper Givetian; and the Roadwater Limestone is Upper Givetian. The Givetian–Frasnian boundary probably lies within the Leighland Beds, towards the top of the Ilfracombe Beds. In the light of the present study, Wedekind's Middle Devonian rugose coral zonal scheme is seen to be in need of considerable modification.

THE Devonian corals and brachiopods of the Ilfracombe Beds of west Somerset have received comparatively little attention in the past, possibly owing to the poor state of preservation of the brachiopods, and to the recrystallization of the corals. Perceval (1866, p. 185) listed twelve coral species from a locality near Sandhill Farm, Withycombe, and also mentioned that spiriferids were common, while Etheridge (1867, p. 593) gave a comparable list for the same locality (= his Hill Farm locality) and, in addition, identified corals from Golsoncott (p. 594) and from limestone bands at Wheddon Cross and Luckwell (p. 586). Lang and Smith (1935), in their redescription of *Disphyllum aequiseptatum* (Milne-Edwards and Haime), figured material collected by Perceval from Sandhill Farm, and indicated that *Disphyllum* {*Phacellophyllum*} *trigemme* (Quenstedt) occurs abundantly in the Ilfracombe Beds (Upper Givetian–Lower Frasnian) at Withycombe. Another important fauna, including brachiopods, corals, trilobites, and lamellibranchs, was described by Whidborne (*in* Hicks 1897, p. 441) from the slates at Treborough. Hicks ascribed this slate sequence to the Morte Slates, a mistaken correlation, as already emphasized by Ussher (1908). It can be clearly demonstrated that the slates at Treborough occur stratigraphically immediately above and below the Roadwater Limestone, and therefore appertain to part of the Ilfracombe Beds succession rather than to the Morte Slates as Hicks suggested.

Owing to the recrystallization of the corals, only relic structural elements have been retained. As a result, the original structures are readily observable in thin-sections prepared thicker than usual, but further grinding and polishing results in the total loss of the structures. Cellulose peels were also used but failed to give consistent results. The most satisfactory methods for studying the west Somerset material were to use polished sections for those corals differentially stained by percolating solutions from the New Red Sandstone, and thick thin-sections or cellulose peels for the other material.

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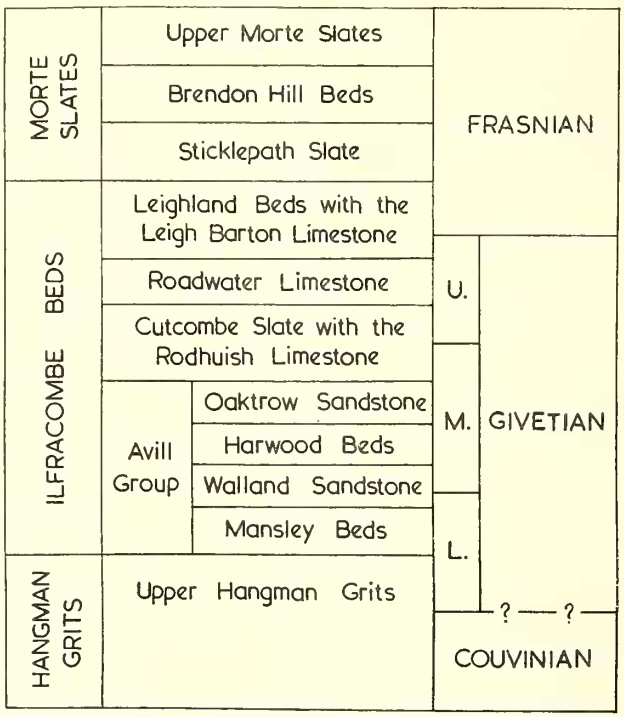
STRATIGRAPHICAL PALAEONTOLOGY

The detailed stratigraphical succession for the Brendon Hills is shown in text-fig. 1, and has been summarized by Webby (1962*b*). The lowest unit, the Upper Hangman Grits, has yielded only plant fragments, and lamellibranchs from near the top of the formation. The overlying Hangman–Ilfracombe contact is quite sharp, consisting of a change from the predominant quartzitic sandstones of the Upper Hangman Grits to the alternating slates and thinly bedded siltstones of the Mansley Beds (lowest formation of the Avill Group), a distinctive lithology which seems to be identical with that of the Wild Pear Beds near Combe Martin, north Devon. This lithological correlation is supported by the fact that on the north Devon coast the Wild Pear Beds are underlain



TEXT-FIG. 1. The Devonian stratigraphical divisions in the Brendon Hills.

by the Hangman Grits and overlain by the Lester Series (Evans 1922), the last being equivalent to the middle and upper parts of the Avill Group (Walland Sandstone, Harwood Beds, and Oaktrow Sandstone) in the Brendon Hills. However, there is an important difference in the respective sequences of north Devon and west Somerset, because near Combe Martin the upper part of the Hangman Grits contains beds with *Stringocephalus* cf. *burtini* (Defrance), while in west Somerset it appears to be absent. Possibly the lamellibranch horizon in the Upper Hangman Grits is at the equivalent stratigraphical horizon in the Brendon Hills.

No brachiopod faunas have been found in the Mansley Beds and the Walland Sandstone, but the succeeding formations, the Harwood Beds and the Oaktrow Sandstone,

have yielded brachiopods, lamellibranchs, gastropods, and Polyzoa, and the Oaktrow Sandstone has also yielded *Decadocrinus oaktrovensis* Webby. The brachiopods from the Oaktrow Sandstone are: *Schuchertella sp.*, *Cupularostrum? sp.*, *Spinocyrtia ascendens* (Spriestersbach), '*Spirifer*' *sp.*, *Thomasaria gibbosa* Vandercammen, *Athyris? sp.*, *Cyrtina sp.*, *Centronella sp.*, and *Cranaena sp.* The occurrence of *Spinocyrtia ascendens* in the Oaktrow Sandstone, and also the Harwood Beds, is of considerable interest, for this species seems to be a useful index-fossil of the Givetian in Germany. It is almost certainly identical with many, if not most, of the forms hitherto referred to *Spirifer mediotextus* Archiac and Verneuil both in Belgium and Germany. *S. mediotextus* is given as the index-fossil for the Gic Zone of the Belgian Givetian type-succession, on the south side of the Dinant Basin (Lecompte and Waterlot 1957, p. 241). *Thomasaria gibbosa* has an Upper Givetian to Frasnian range in Belgium (Webby 1962*a*, p. 538). By considering the overlapping time-ranges of *Spinocyrtia ascendens* and *T. gibbosa*, it might be suggested that the Oaktrow Sandstone was Upper Givetian. However, as will be seen below, the coral evidence from the stratigraphically higher limestones suggests that the limestones are Upper Givetian; hence it seems likely that the Oaktrow Sandstone, and probably also the Harwood Beds, are Middle Givetian.

The presence of two distinct coralliferous limestones has been established, the lower named the Rodhuish Limestone, and the upper the Roadwater Limestone. The Rodhuish Limestone is restricted to the area around Rodhuish, and passes laterally into the Cutcombe Slate. The Roadwater Limestone is more or less persistent from Sandhill Farm, Withycombe, southwards to Roadwater, and thence westwards to Wheddon Cross. The rugose and tabulate corals are restricted to these two limestone formations. The following corals have been collected from the Rodhuish Limestone: *Heliophyllum halli* Milne-Edwards and Haime, *Disphyllum aequiseptatum* (Milne-Edwards and Haime), *Thamnophyllum caespitosum* (Goldfuss), '*Cystiphyllum*' *secundum* (Goldfuss), *Thamnopora* aff. *crouigera* (d'Orbigny) and *T. reticulata* (de Blainville). It should be noted that Schlüter (1889) described the type-species *Mesophyllum defectum* from one of the Goldfuss syntypes of '*Cystiphyllum*' *vesiculosum*, and Stumm (1949) designated it as lectotype, thereby making it *Mesophyllum vesiculosum*. Dr. R. Birenheide has indicated (pers. comm.) that the specimen selected by Schlüter is a compound form figured by Goldfuss in plate 17, fig. 5*e*, and that certain of the other Goldfuss syntypes should be grouped with '*C.*' *secundum* (Goldfuss). The west Somerset specimens are accordingly assigned to '*C.*' *secundum*.

The Cutcombe Slate and Rodhuish Limestone have yielded only a few poorly preserved, indeterminate brachiopods. Only *Cyrtospirifer sp.* has been identified from the Rodhuish Limestone. At Treborough the brachiopods and corals described by Whidborne (*in* Hicks 1897) were collected from the slates below the limestone band (and, therefore, from the topmost beds of the Cutcombe Slate). A revision of their material has demonstrated that much less confident palaeontological assignments than those given by Whidborne are probable. The new assessment does not support a Lower Devonian age as Hicks formerly suggested (1897, p. 444).

An abundant and varied coral fauna has been obtained from the Roadwater Limestone, and a small, comparatively unimportant, brachiopod fauna. The faunal list is as follows: *Syringaxon sp.*, *Heterophrentis percevali* sp. nov., *Heliophyllum halli* Milne-Edwards and Haime, *Disphyllum aequiseptatum* (Milne-Edwards and Haime),

Phillipsastrea sp., *Thamnophyllum caespitosum* (Goldfuss), *Endophyllum abditum* Milne-Edwards and Haime, *Acanthophyllum* (*Neostringophyllum*) *concavum* (Walther), *Digonophyllum* (*Digonophyllum*) *bilaterale*? (Champernowne), *Mesophyllum* (*Arcophyllum*) *sandhillense* sp. nov., '*Cystiphyllum*' *secundum* (Goldfuss), *Thamnopora cervicornis* (de Blainville), *T. reticulata* (de Blainville), *T. polyforata* (Schlotheim), *Alveolites suborbicularis* Lamarck, *Thecostegites sp.*, *Cyrtina heteroclita* (Defrance), *Schizophoria sp.*, rhynchonellid and productid species. The commonest corals are *Thamnophyllum caespitosum* and *Thamnopora cervicornis*, while *Disphyllum aequiseptatum*, *Heliophyllum halli*, and '*Cystiphyllum*' *secundum* are also important. Other species are not abundant.

No determinable faunas have been recovered from the overlying Leighland Beds. In the Leigh Barton Limestone, near the top of the Leighland Beds, *Cyrtospirifer sp.* and other indeterminate brachiopods have been obtained, but nothing that assists in determining the age of the beds.

The Morte Slates contain few fossils, which are invariably poorly preserved or distorted. *Cyrtospirifer sp.* has been collected from the Sticklepath Slate, in the lower part of the Morte Slates, and Whidborne has identified a trilobite, brachiopods, and lamellibranchs in the Upper Morte Slates from Oakhampton Quarry, near Wiveliscombe, to the south of the Brendon Hills (Hicks 1897, p. 443).

Age of the Rodhuish and Roadwater Limestones. In the absence of more precise zonal fossils it has become necessary to rely mainly on the rugose and tabulate corals for determining the age of the Devonian limestones in the Brendon Hills. Perhaps the most certain determination of the age of the limestones is obtained from a study of the whole aspect of the coral fauna within the limestones. The Roadwater Limestone altogether includes 16 different coral species, of which 11 are rugose and 5 tabulate corals. A number of the rugose corals are typical Middle Devonian species, for instance *Heliophyllum halli* and '*Cystiphyllum*' *secundum*, while species of *Heterophrentis*, *Endophyllum*, *Digonophyllum* (*Digonophyllum*), and *Mesophyllum* (*Arcophyllum*) are restricted to the Middle Devonain elsewhere in Europe and North America. The presence of *Acanthophyllum* (*Neostringophyllum*) *concavum* is interesting since it appears to be restricted to the Upper Givetian of the Bergisches Land, the uppermost Eifelian and Givetian in the Eifel (Birenheide 1961, p. 125) and the Upper Givetian in Moravia (Ketternová 1932, p. 45). The species of *Phillipsastrea* collected from the Roadwater Limestone is possibly *P. hennahi* (Lonsdale), the same form as is found in the limestones of the Ilfracombe Beds at Doddington, on the northern flank of the Quantock Hills. *Phillipsastrea* is regarded as a typical Frasnian form by Smith (1945, p. 37), whereas both Taylor (1951, p. 192) and Middleton (1959, p. 156) recorded it in the upper Middle Devonian of south Devon, and Middleton from as low as his upper Sp Zone of the middle Middle Devonian. Presumably, the occurrence of this genus indicates an horizon high in the Middle Devonian, for it is not a characteristic Middle Devonian form in Europe. The association of this typically Frasnian form with the predominant Middle Devonian rugose coral element in the Roadwater Limestone strongly suggests that the horizon is situated not far below the Givetian–Frasnian boundary, viz. in the Upper Givetian.

The tabulate corals of the Roadwater Limestone include three species of *Thamnopora: T. cervicornis*, *T. polyforata*, and *T. reticulata*. The time-ranges for numerous species of *Thamnopora* in the Middle and Upper Devonian of the Dinant Basin, given by Lecompte

(1939, p. 198), shows that *T. cervicornis* ranges through the whole of the Givetian in the Dinant succession, *T. polyforata* (= *dubia*) ranges from topmost Givetian (Gid) to Frasnian, and *T. reticulata* ranges from Couvinian (Co2) to Frasnian. On the basis of the overlapping time-ranges of *T. cervicornis* and *T. polyforata*, the Roadwater Limestone may be tentatively correlated with the Gid Zone, or the Upper Givetian. In addition, the occurrence of *Thecostegites* points to a position close to the Givetian–Frasnian boundary, because the type species *Thecostegites bouchardi* (Michelin), which it resembles, is recorded from the Frasnian at Ferques and in the Dinant Basin (Milne-Edwards and Haime 1851; Lecompte 1939).

The Rodhuish Limestone contains no typical Upper Devonian forms. *Thamnophyllum caespitosum* and *Thamnopora reticulata* may occur in the Frasnian, but they are just as common in the Givetian. All the other species, particularly *Heliophyllum halli* and '*Cystiphyllum*' *secundum*, are typically Middle Devonian forms. Although the Rodhuish Limestone does not contain *Thamnopora cervicornis*, it does yield a form closely similar to *T. cronigera*, which in the Dinant succession ranges through the Middle Givetian (Gib to Gic). From its relationship to the Oaktrow Sandstone below and the Roadwater Limestone above, and from its coral content, the Rodhuish Limestone may be regarded as Middle or Upper Givetian in age.

The total evidence adduced from the coral faunas of the Ilfracombe Beds in the Brendon Hills thus indicates that the Rodhuish Limestone is Middle–Upper Givetian, and the Roadwater Limestone is Upper Givetian. The Givetian–Frasnian boundary lies above the Roadwater Limestone but the precise position remains in doubt. Until a good fauna is obtained from the Leighland Beds, or its equivalent stratigraphical horizon in another area, nothing can be said with certainty on its precise position, which may lie within the Leighland Beds (text-fig. 1), or it might be a little higher, perhaps at the contact between the Ilfracombe Beds and the Morte Slates.

For convenience the Morte Slates may be considered to be Frasnian, though as yet no indubitable Frasnian fossils have been found.

Correlation of the Rodhuish and Roadwater Limestones, and the Wedekind Zonal Scheme. On the north Devon coast, Evans (1922) identified a number of different limestone bands within the Ilfracombe Beds, placing the Givetian–Frasnian boundary between the Red Limestone Series and the David's Hole Beds. He referred to well-preserved corals—identified by Stanley Smith as *Endophyllum* (*Spongophyllum*) *bowerbanki* Milne-Edwards and Haime, *Cyathophyllum caespitosum* and *Pachypora cervicornis*—in the Jenny Start Beds, which underlie the Red Limestone Series, and are, therefore, included in the Givetian. Holwill (1961) re-examined the coastal section and concluded that there are only three limestones, which are repeated by folding and faulting; the oldest, the Jenny Start Limestone, is correlated with the Givetian, followed by the Combe Martin Beach Limestone and the David's Stone Limestone, both of which are thought to be Lower Frasnian.

More recently, Holwill (1963) has indicated that the Combe Martin Beach Limestone contains the corals *Barrandeophyllum*, *Syringaxon*, *Metriophyllum*, *Alveolites*, and *Thamnopora*, while the overlying David's Stone Limestone includes *Syringaxon*, *Barrandeophyllum*, and *Thamnopora*. He considered the species of *Metriophyllum* to be close to *M. bouchardi* from the Frasnian of the Boulonnais. As yet *Barrandeophyllum* and

Metriophyllum have not been confirmed in the limestones of the Brendon Hills. If they characterize a limestone horizon higher than the Roadwater Limestone, then there must be important facies changes between north Devon and west Somerset.

Correlations with south Devon are even more uncertain. The only recent work on corals is by Taylor (1951) and Middleton (1959), who have adhered closely to Wedekind's zonal scheme as their basis for dating the Middle Devonian limestones. The scheme was established by Wedekind (1923, 1924, 1925, 1937) from his studies of rugose corals in the Eifel, and used subsequently outside Germany with modifications by Soshkina (1936) in Russia, and Taylor (1951) and Middleton (1959) in south Devon.

The recent work of Birenheide (1961) placing *Grypophyllum* as a subgenus of *Acanthophyllum* is indicative of the close relationship between the acanthophyllids and grypophyllids. Furthermore, *Ptenophyllum* (*Ptenophyllum*), *Ptenophyllum* (*Astrophyllum*) and *Ptenophyllum* (*Rhopalophyllum*), *Leptoinophyllum* and *Stenophyllum* (*partim.*) are considered as synonyms of *Acanthophyllum*, and *Neostringophyllum* as a subgenus, like *Grypophyllum*. According to the Wedekind zonal scheme, acanthophyllids (*sensu stricto*) are restricted to the lower Middle Devonian (*Digonophyllum* Zone to *Dohmophyllum* Zone inclusive); *Leptoinophyllum* is abundant in the *Leptoinophyllum* Zone and the grypophyllids are abundant in the *Stenophyllum* and *Sparganophyllum* Zones of the middle Middle Devonian; and *Neostringophyllum* occurs in the *Dialytophyllum* Zone of the upper Middle Devonian. All the cited forms are closely related and are now included in the one genus, *Acanthophyllum*. Thus, the acanthophyllids (*sensu lato*) extend from the base of the lower Middle Devonian to the upper Middle Devonian and, accordingly, are not useful zonal indicators, except in a more general sense than that intended by Wedekind.

The digonophyllids, according to the Wedekind scheme, are restricted to the lower part of the lower Middle Devonian, whereas Ketternová (1932) recorded three species of *Digonophyllum* (*Digonophyllum*) from the Givetian limestones of Čelechovice, in Moravia, and *Digonophyllum* (*Digonophyllum*) *bilaterale*? is present in the Upper Givetian Roadwater Limestone in the Brendon Hills. Middleton (1959, p. 140) suggested that digonophyllids may be found even as high as the upper Middle Devonian, and the west Somerset occurrence strongly endorses this view.

Another modification of the zonal scheme seems necessary, as the keriophyllids were regarded as restricted to the lower Middle Devonian. There is much difference of opinion on the interpretation of the genera *Heliophyllum* and *Keriophyllum*. Wedekind (1923) and Haller (1935) have not recognized *Heliophyllum* for their German forms; Stumm (1949, p. 21) regarded *Keriophyllum* as congeneric with *Heliophyllum*; Hill (*in* Moore 1956, p. F278) recognized both *Heliophyllum* and *Keriophyllum*, the chief difference between them being the yard-arm carinae of the former, and the zigzag carinae of the latter; and Middleton (1959, p. 155) regarded *Keriophyllum* as a subgenus of *Heliophyllum*. Birenheide (1962) has indicated that most of Wedekind's and Haller's species of *Keriophyllum* should be assigned to *Cyathophyllum* (*Cyathophyllum*) Goldfuss and *Cyathophyllum* (*Peripaedium*) Ehrenberg, and only '*K.*' *dahlemense* Haller should be assigned to the genus *Heliophyllum*. The validity of the *Keriophyllum* Zone thus becomes open to question, unless *Heliophyllum dahlemense*, which characterizes the Dahlemer *Keriophyllum* Zone, is excluded. The range of *Heliophyllum* in Europe appears

to be at least from the lower Middle Devonian (as indicated by *H. dahlemense* in the Eifel) to upper Middle Devonian (as suggested by *H. halli* in the Brendon Hills).

Wedekind (1925, 1934) indicated that lythophyllids are abundant in the middle Middle Devonian and absent from the upper Middle Devonian. An exception to this is seen in the presence of '*Cystiphyllum*' *secundum* (= *Lythophyllum septatum* Wedekind and *L. corneolum* Wedekind and Vollbrecht) in the upper Middle Devonian Rodhuish and Roadwater Limestones of west Somerset.

The Wedekind zonal scheme must be modified to accommodate all the exceptions before it can become an effective tool in European Middle Devonian stratigraphical studies, or else its use must be restricted to Germany. The zonal scheme could not be applied to rugose corals in limestones of the Brendon Hills. Instead, age determination of the limestones has been founded on complete faunal analysis of the rugose and tabulate corals.

SYSTEMATIC DESCRIPTIONS

Numbers of specimens catalogued in the Geology Department Collection, Bristol University, are prefixed BU; those from the British Museum (Natural History) by BM; and those from the Geological Survey Museum by GSM.

Phylum COELENTERATA
Order RUGOSA
Suborder STREPTELASMATINA Wedekind 1927
Superfamily ZAPHRENTICAE Milne-Edwards and Haime 1850
Family STREPTELASMATIDAE Nicholson, *in* Nicholson and Lydekker 1889
Genus HETEROPHRENTIS Billings 1875

Type species. H. spatiosa Billings 1875.

Diagnosis. Solitary, large, ceratoid to trochoid; cardinal fossula on convex side; septal stereozone narrow; major septa with very sparse axial lobes, slightly withdrawn from the axis; tabulae complete or incomplete, flat-topped to axially depressed domes, depressed at the fossula.

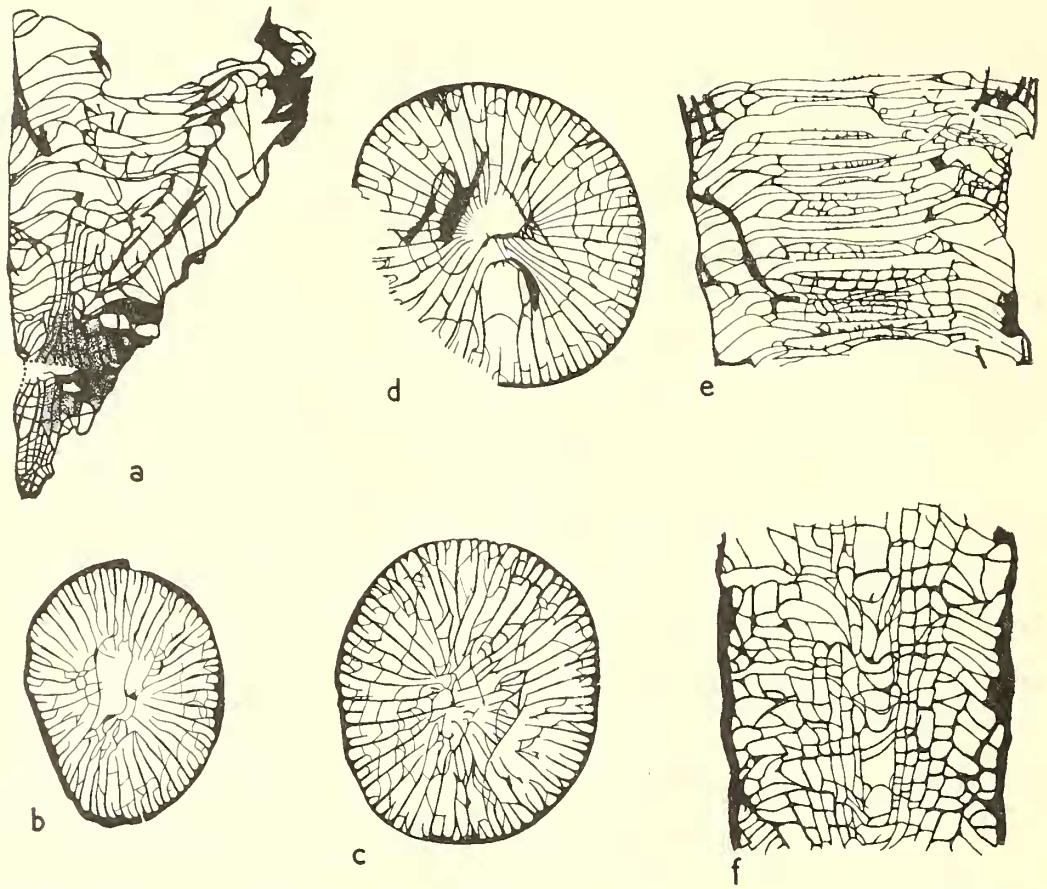
Heterophrentis percevali sp. nov.

Text-fig. 2*a–f*

Diagnosis. Heterophrentis with major septa extending two-thirds the distance to the axis, minor septa usually short and contratingent; 38–44 major septa in the ephebic stage; cardinal fossula commonly indistinct.

Description. Simple trochoid to ceratoid coral, slightly curved, attaining a length of 14 cm., and a diameter of 35 mm. Calice moderately deep, more than 10 mm., with fairly steeply inclined sides. Wall less than 1 mm. thick. Major septa long and thin, apart from peripheral dilatation, extending to two-thirds the distance from periphery to axis, or slightly more, in the ephebic stage; number—38 to 44 in sections of between 22 and 28 mm. average diameter. Minor septa short, about one-fifth the length of the major, and often contratingent. Cardinal fossula clearly observed in two specimens (paratypes

BU 18092 and 18224); in others it is indistinct. Tabulae make up a series of complete and incomplete floors, flat or gently sagging in the axial region, arched in the periaxial region, and sloping downwards towards the periphery. A longitudinal section at right angles to the cardinal fossula shows the tabulae bent downwards across it. No dissepiments.



TEXT-FIG. 2. *Heterophrentis percevali* sp. nov. *a*, Holotype, BU 18090, longitudinal section. *b*, *c*, Paratype, BU 18091, transverse sections at different levels, 17 mm. apart. *d*, Paratype, BU 18224, transverse section showing cardinal fossula. *e*, Paratype, BU 18224, longitudinal section. *f*, Paratype, BU 18092, longitudinal section in the periaxial region showing tabulae bent downwards across the cardinal fossula. All the figured specimens are from the Roadwater Limestone, *a–e* from Sandhill Farm and *f* from between Wheddon Cross and Luckwell Bridge. All enlargements ×1·5.

Remarks. Champernowne (1884) described a number of Devonian corals from south Devon, several of which clearly belong to the Streptelasmatidae. He assigned two specimens to *Zaphrentis sp.*, one of which (plate 23, fig. 1*a–b*; BM R23461) is similar to *Heterophrentis percevali*, but differs in having thicker major septa, while the other (plate 21, fig. 7), a specimen which cannot be traced, is smaller and has fewer major septa. Another specimen (GSM 75731) from Woolborough, south Devon, is also similar,

and may be conspecific. It has an average diameter of 30 mm., long major septa, numbering 44, and short minor septa, differing only in the possession of a thicker wall, slightly more than 1 mm. in thickness.

Le Maître (1934, p. 146) described *Streptelasma armoricanum* from the Lower–Middle Devonian strata of the Ancenis Basin, France, which may be a species of *Heterophrentis*. From her description and figures (plate 5, figs. 1, 2—the latter being orientated upside down), it is apparent that there are a number of similarities to the west Somerset specimens. The simple corals are of large dimensions, with a diameter of 17 to 30 mm., and carry a thick wall of stereozone from 1 to 5 mm. in thickness. The major septa are stated to number 44 to 50 in the sections studied, but only 37 major septa are visible in the specimen figured in transverse section. Dissepiments are stated to occur between major septa, although they are lacking in the figured longitudinal section. The traces giving the appearance of dissepiments in the transverse section are probably intercepted portions of the downward turned tabulae in the periaxial region. No well-defined fossula is apparent. The main differences between *Streptelasma armoricanum* and *H. percevali*, based on Le Maître's description, are the thicker wall, the greater number of major septa (44–50), and the presence of dissepiments in the former.

In comparison with North American species of *Heterophrentis*, *H. percevali* bears the closest resemblance to *H. ferronensis* Stumm (1962, p. 235, pl. 1, figs. 1–7; pl. 2, figs. 1–6). The main differences are that in most specimens of *H. percevali* the cardinal fossula is indistinct, there are fewer major and minor septa, the walls are uniformly thin and, at least in one specimen (BU 18224), the coral attains a much greater length. Greater differences are exhibited by other North American species, such as those described by Stewart (1938). The range of the North American forms is from Lower to Middle Devonian, being most common in horizons of the lower Middle Devonian.

Derivation of name. In honour of S. G. Perceval, for his thorough collecting and for his invaluable faunal list (1866, p. 185) from the coralliferous limestone at Sandhill Farm, Withycombe.

Holotype. BU 18090. *Paratypes.* BU 18091–2, 18224–5; BM R16184, R16211–12; GSM 86215.

Occurrence. Present in the Roadwater Limestone north of Rodhuish, and between Wheddon Cross and Luckwell Bridge, west Somerset. It may also occur in south Devon.

Family PHILLIPSASTRAEIDAE C. F. Roemer 1883
Genus THAMNOPHYLLUM Penecke 1894

Type species. T. stachei Penecke 1894.

Diagnosis. Dendroid or phaceloid, corallites united by dissepimental tissue at axils of branches; septa withdrawn from axis and dilated in dissepimentarium; dissepiments consisting of an outer row of flat plates and an inner row of horse-shoe plates, often replaced by stereoplasmic thickening; tabulae complete or incomplete, flat or slightly bowed.

Thamnophyllum caespitosum (Goldfuss)

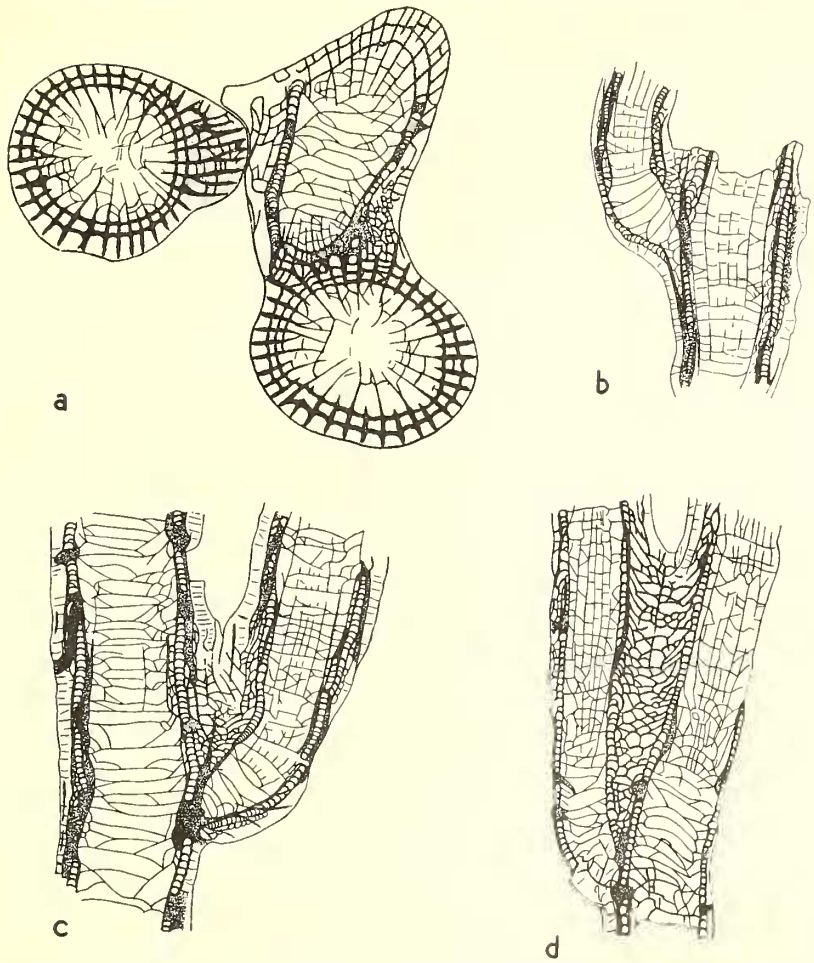
Text-fig. 3*a–d*

1826 *Lithodendron caespitosum* Goldfuss, p. 44, pl. 13, fig. 4.
1935 *Displyllum {Phacellophyllum} caespitosum* Lang and Smith, p. 573, pl. 35, figs. 1, 2; text-figs. 28, 29.

1949 *Macgeea* (*Thamnophyllum*) *caespitosa* Schouppé, p. 138, pl. 9, fig. 3; pl. 11, figs. 40–43 (*cum syn.*).
1949 *Phacelophyllum caespitosum* Stumm, p. 36, pl. 17, figs. 11–13.
1951 *Disphyllum* {*Phacellophyllum*} *caespitosum* Taylor, p. 186, pl. 3, fig. 3*a*, *b*; *non* fig. 4*a*, *b*.
1956 *Thamnophyllum caespitosum* Różkowska, p. 308, text-figs. 30–32.
1957 *Thamnophyllum caespitosum* Różkowska, p. 89, text-fig. 8.
1958 *Macgeea* (*Thamnophyllum*) *caespitosum* Schouppé, p. 227, text-figs. 7–9.
1962 *Thamnophyllum* cf. *caespitosum* Assereto, p. 11.

Description. Corallum is large, compound, and typically phaceloid. Corallites cylindrical, frequently showing lateral branching, occasionally with two or three branches arising from one level. Diameter of corallites varies from 4 to 13 mm., the average being close to 6 mm. Occasionally the corallum is sub-dendroid, with corallite-diameters greater than the average for the species, and large sediment-filled spaces between the corallites. Lateral buds develop at right angles to the mother corallite, and show little tendency to curve upwards into a similar alignment to that of the mother corallite (text-fig. 3*a*). Dissepimental tissue between the mother and daughter corallites (plocoid structure of Lang and Smith 1935) is reduced or absent. Most commonly the corallum is phaceloid, with corallite-diameters about the average for the species, and narrow sediment-filled spaces between corallites. Lateral buds curve sharply almost into parallelism with the mother corallite, and at the point of division are united by dissepimental tissue (text-fig. 3*b*, *c*). Occasionally the corallites are more tightly packed, and there are only thin sediment-filled spaces between corallites. The corallite-diameters are about, or less than, the average for the species. Lateral buds curve even more sharply into line with the mother corallite, and they are united by dissepimental tissue for upwards of 25 mm. from the point of furcation (text-fig. 3*d*). The extreme of close packing is seen in a few cerioid to sub-cerioid forms (BU 10088, 18226; BM R16167). It is not yet clear whether these forms are linked throughout growth, or merely represent a level at which a large number of daughter corallites develop. In different specimens the number of major septa varies from 14 to 24, but is usually 18 to 19. Major septa usually extend inwards to 1 mm. from the axis, and they are attenuated within the tabularium. Minor septa are about half the length of the major. Both major and minor septa are dilated in the dissepimentarium, which includes an outer row of flat dissepiments, and an inner row of horseshoe dissepiments. Sometimes the inner and outer rows are not continuous along the length of the corallite, and appear to be replaced by stereoplasmic thickening. Tabularium occupies about half the diameter of the corallite. Two types of tabulae are present, inner flat or slightly domed tabulae, and outer smaller, axially inclined, arched tabulae on the margin of the tabularium.

Remarks. This species was formerly the type species of *Phacellophyllum*, but it has been assigned to *Thamnophyllum* by Schouppé (1949) and Różkowska (1956, 1957). They studied the variability of the amount of stereoplasmic thickening in different species of *Thamnophyllum*, and considered that *T. caespitosum* fell within this range of variability. The main differences from the type species, *T. stachei* Penecke (Lang and Smith 1935, p. 581), are the longer major septa, the lesser stereoplasmic thickening, and the different mode of budding, characters which cannot be regarded as diagnostic of a different genus. Therefore, *Phacellophyllum* should be regarded as a synonym of *Thamnophyllum*.



TEXT-FIG. 3. *Thamnophyllum caespitosum* (Goldfuss). *a*, BU 18105, transverse section of two corallites, one with a lateral bud. *b*, BU 18108, longitudinal section of a corallite with a lateral bud. *c*, BU 18106, longitudinal section of a corallite with a lateral bud. *d*, BU 18107, longitudinal section of corallite with a lateral bud in a tightly packed corallum. All figured specimens are from the Roadwater Limestone at Sandhill Farm, except for *a*, which is from the Rodhuish Limestone at Higher Rodhuish Farm. All enlargements ×2·5.

Occurrence. Widespread and common in the Middle and lower Upper Devonian of Europe. It is present in the Ilfracombe Beds of north Devon and west Somerset, and in south Devon. In the Brendon Hills it is common in both Rodhuish and Roadwater Limestones.

Suborder COLUMNARIINA Rominger 1876
Family PTENOPHYLLIDAE Wedekind 1923
Genus ACANTHOPHYLLUM Dybowski 1873

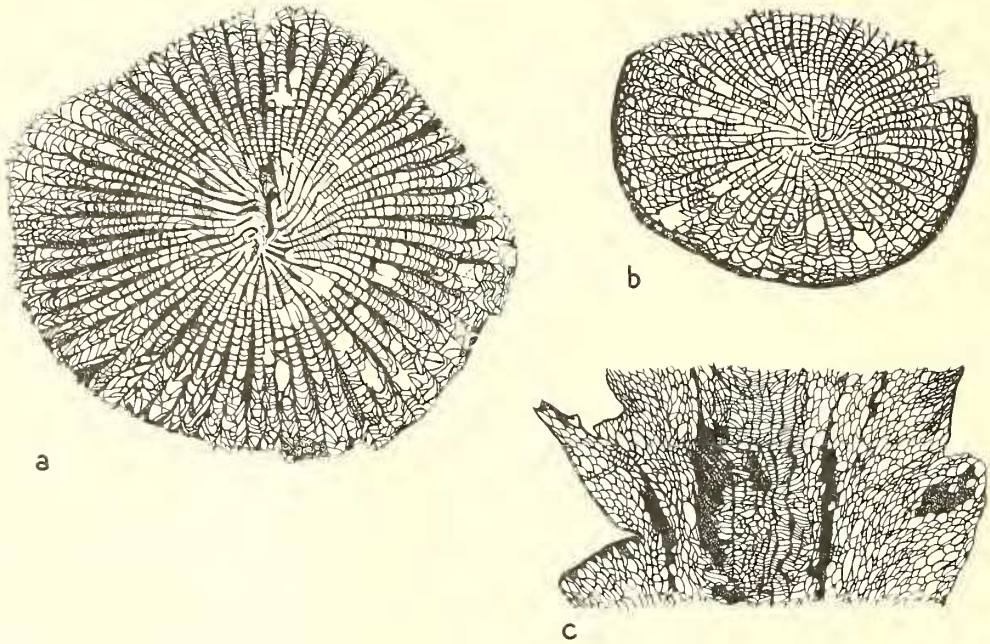
Type species. Cyathophyllum heterophyllum Milne-Edwards and Haime.

Diagnosis. See Birenheide (1961, p. 81).

Subgenus NEOSTRINGOPHYLLUM Wedekind 1922

Type species. Neostringophyllum ultimum Wedekind 1922.

Diagnosis. See Birenheide (1961, p. 124).



TEXT-FIG. 4. *Acanthophyllum* (*Neostringophyllum*) *concavum* (Walther). *a*, BM R16533, transverse section, Roadwater Limestone at Sandhill Farm. *b*, BU 18222, transverse section, limestones of the Ilfracombe Beds at Lower Aisholt, Quantock Hills. *c*, BU 18223, longitudinal section, locality as for *b*. All enlargements × 1·5.

Acanthophyllum (*Neostringophyllum*) *concavum* (Walther)

Text-fig. 4*a–c*

1886 *Endophyllum acanthicum* Frech, p. 87, pl. 6, fig. 1 only.
1922 *Cyathophyllum heterophyllum* Paeckelmann, p. 68.
1925 *Neostringophyllum sp.* Wedekind, pl. 11, figs. 66–69; *non* pl. 16, figs. 93, 94.
1928 *Neostringophyllum concavum* Walther, p. 114, text-fig. 8.
1928 *Neostringophyllum simplex* Walther, p. 113, text-fig. 7.
1928 *Neostringophyllum planum* Walther, p. 113, text-fig. 6.
1932 *Sparganophyllum delicatum* Ketternová, p. 45, text-figs. 28, 29.
1961 *Acanthophyllum* (*Neostringophyllum*) *concavum* Birenheide, p. 125, pl. 7, figs. 23, 24.

Description. Large solitary coral, subcylindrical. Epitheca thin. Greatest length observed is 9 cm., and the average diameter 35 mm., though one specimen (BM R16533) reaches a diameter of 45 mm. Between 68 and 74 septa, consisting of alternate major and minor. Major septa extend to the axis and have slightly twisted and swollen ends; they attenuate near the periphery, dilate across the inner part of the dissepimentarium, become slightly less dilated in the outer part of the tabularium, and then swell at their axial ends. Minor

septa are thinner and extend to about two-thirds of the length of the major. Tabularium occupies one-third of the diameter of the coral. In longitudinal section the dissepimentarium and tabularium are quite distinct. Herringbone and lateral dissepiments occur in the outer part of the dissepimentarium, but mostly the former type, while dissepiments of normal type occupy the inner part of the dissepimentarium. Dissepiments small, globose, inclined at a moderate angle to the periphery, though becoming steeply inclined towards the tabularium, and also slightly more elongated. Floor of tabularium gently concave with numerous closely spaced, flat, gently concave or gently convex tabellae; an average of about three tabellae to the millimetre.

Remarks. The specimens from Sandhill Farm, Withycombe, and Lower Aisholt, Quantock Hills, agree closely with the description of *Acanthophyllum* (*Neostringophyllum*) *concavum* given by Birenheide (1961, p. 125). *Neostringophyllum planum* Walther (1928, p. 113) is also considered synonomous with *A.* (*N.*) *concavum*, only differing in a smaller diameter (20–22 mm.) from the west Somerset specimens.

Occurrence. Acanthophyllum (*Neostringophyllum*) *concavum* has its type-locality in the Upper Givetian Schwelmer Kalk of the Bergisches Land, and it also occurs in the Junkerberg Schichten, Fleringer Schichten, and Dreimühlen Schichten of the Upper Eifelian and Lower Givetian in the Eifel (Birenheide 1961). It is also found in the Upper Givetian Čelechovice limestones of Moravia (Ketternová 1932, p. 45). In west Somerset four specimens have been collected from Sandhill Farm, Withycombe, from the Roadwater Limestone (BM R16533, R16196, R16218; GSM 75710), and two specimens from limestones at Lower Aisholt, Quantock Hills (BU 18222–3).

Suborder CYSTIPHYLLINA Nicholson, *in* Nicholson and Lydekker 1889
Family DIGONOPHYLLIDAE Wedekind 1923
Genus MESOPHYLLUM Schlüter 1889

Type species. Cyathophyllum vesiculosum Goldfuss 1826.

Diagnosis. See Hill (*in* Moore 1956, p. F318).

Subgenus ARCOPHYLLUM Markov 1926

Type species. A. typus Markov 1926.

Diagnosis. See Hill (*in* Moore 1956, p. F318).

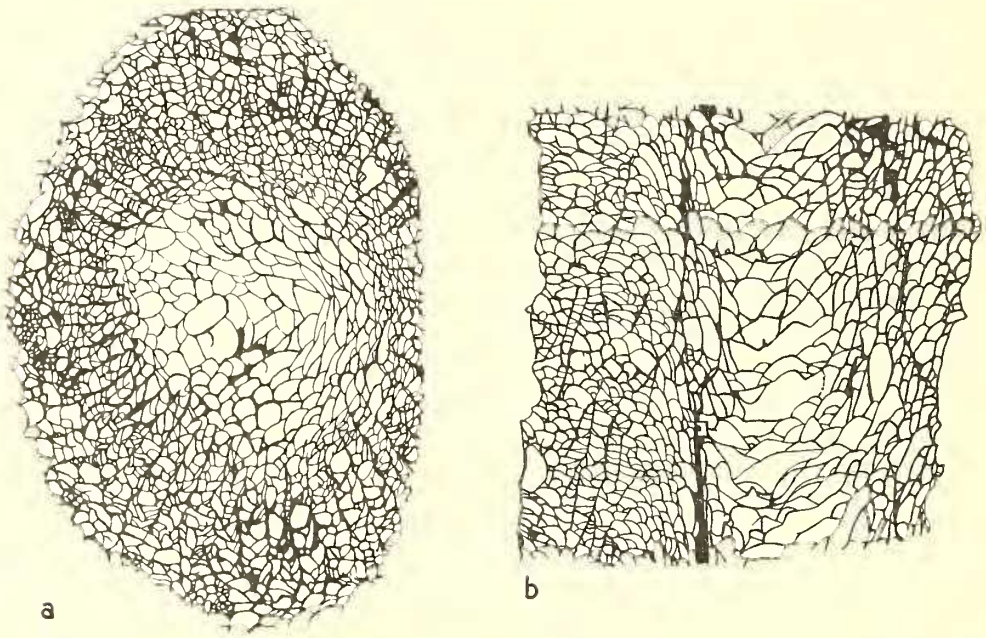
Mesophyllum (*Arcophyllum*) *sandhillense* sp. nov.

Text-fig. 5*a*, *b*

Diagnosis. Large *Mesophyllum* (*Arcophyllum*) with a bell-shaped calice; tabularium occupies one-third, or slightly more, of the diameter. Septa withdrawn from the axis and periphery, and mainly restricted to the inner part of the dissepimentarium; minor septa short or absent; approximately fifty major septa. Tabellae large. Carinae developed but not obvious in transverse section.

Description. Corallum is large, single, and subcylindrical; paratype 7 cm. long, and

expands in this length from 36 to 45 mm. Calice is bell-shaped, 15 to 18 mm. deep. Holotype is oval in transverse section, 45 mm. minimum diameter, 70 mm. maximum diameter (an average of 57 mm.). The outer surface is seen in a small part of the paratype where there are vague annulations. Major septa estimated at about fifty, variable in length; some extend almost across the dissepimentarium, others short and restricted to the middle or inner part of the dissepimentarium. Minor septa irregular in distribution; they may alternate between major septa or may be absent. There is a narrow peripheral zone of lonsdaleoid dissepiments. Tabularium occupies one-third, or slightly more, of



TEXT-FIG. 5. *Mesophyllum* (*Arcophyllum*) *sandhillense* sp. nov. *a*, Holotype, BM R16085, transverse section. *b*, Paratype, BM R16087, longitudinal section of the upper part of the corallum. The type specimens are from the Roadwater Limestone at Sandhill Farm. Both enlargements ×1·25.

the diameter. In longitudinal section of the paratype, the dissepimentarium is seen to vary in width; in the lower part the tabularium is markedly asymmetrical, being situated to one side, and the dissepimentarium is broad on one side and virtually absent from the other; towards the middle of the corallum there is still a pronounced asymmetry, but a narrow band of dissepimental tissue has appeared opposite the broad zone; and in the upper part this dissepimental band broadens until it is approximately the same width on both sides of the tabularium (text-fig. 5*b*). The tabularium remains about the same width throughout the length of the corallum, 15 to 18 mm. diameter. Dissepiments, as seen in longitudinal section, are variable in size, somewhat globose, steeply inclined near the inner margin, gradually flattening out towards the periphery. Carinae prominent, steeply inclined to the periphery, more or less straight, sometimes bifurcating. Tabellae large, mostly gently convex, forming a series of concave floors.

Remarks. The type species of *Arcophyllum*, *A. typus* Markov, from the Middle Devonian of the Urals, resembles *Mesophyllum* (*Arcophyllum*) *sandhillense*, differing mainly in being much smaller, in having a narrower tabularium and fewer septa (Markov 1926, p. 54, pl. 3, figs. 3, 5, 7; Soshkina 1949, p. 60, pl. 16, fig. 2; pls. 18–21; pl. 23, fig. 3). *A. septatum* Bulvanker is also similar, but differs in having longer major septa, extending from the middle of the dissepimentarium to well within the tabularium (Bulvanker 1958, p. 63, pl. 25, fig. 2; pl. 26, fig. 1; pl. 27, fig. 1), and *A. markovi* Bulvanker differs in having a broad, flaring form and a funnel-shaped calice (Jakovlev 1947, p. 54, pl. 5, fig. 2). The German species *A. dachsbergi* (Vollbrecht) differs in having a much greater development of peripheral carinae, more complete septa, and smaller tabellae (Wedekind and Vollbrecht 1931, pl. 41, figs. 1, 4; pl. 42, figs. 1–6; pl. 44, fig. 9*a*), and *Hemicosmophyllum limbatum* Wedekind and Vollbrecht is similar, but the septa are fewer, the major septa are slightly longer, extending closer towards the axis, and the minor septa are absent or represented by a few septal crests (Wedekind and Vollbrecht 1931, pl. 45, figs. 6–12; 1932, pl. 12, figs. 1–8). The differences between *Arcophyllum* and *Hemicosmophyllum* are slight, and the only distinction is the somewhat greater continuity of minor septa in *Arcophyllum*. Hill (*in* Moore 1956) regarded *Hemicosmophyllum* as a subgenus of *Mesophyllum*, but it is desirable to regard it as a synonym of *Arcophyllum*, as there does not appear to be any fundamental difference between the two forms.

Holotype. BM R16085–6. *Paratype.* BM R16087.

Occurrence. Two specimens from the Roadwater Limestone at Sandhill Farm, Withycombe.

Order TABULATA
Family FAVOSITIDAE Dana 1846
Subfamily PACHYPORINAE Gerth 1921
Genus THAMNOPORA Steininger 1831

Type species. T. madreporacea Steininger 1831.

Diagnosis. See Lecompte (1939, p. 102).

Thamnopora polyforata (Schlotheim)

Text-fig. 6*a*, *b*

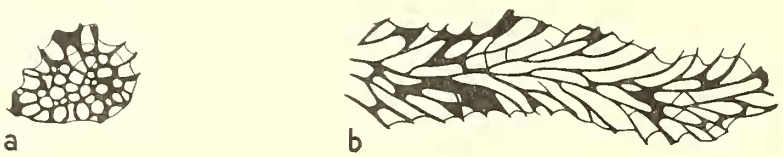
1820 *Milleporites polyforatus* Schlotheim, p. 365, *partim.*
1829 *Calamopora polymorpha* var. *gracilis*, *ramis gracilibus*, *elongatis* Goldfuss, p. 79, pl. 27, fig. 5.
1936 *Favosites dubius* Lecompte, p. 54, pl. 10, fig. 1 (*cum syn.*).
1939 *Thamnopora dubia* Lecompte, p. 120, pl. 18, figs. 7–12.
1945 *Thamnopora polyforata* Smith, p. 63, pl. 28, figs. 1, 2 (*cum syn.*).
? 1952 *Thamnopora polyforata* Smith, p. 301.
1953 *Thamnopora dubia* Kropfitsch and Schouppé, p. 95, pl. figs. 2, 3 (*cum syn.*).
? 1954 *Thamnopora* cf. *polyforata* Hill, p. 31, pl. 1, figs. 7–9.

Description. Small ramous corallum with branches 5 to 7 mm. diameter. Corallites usually subcircular in transverse section, expanding markedly and curving outwards

from the axis to reach the surface obliquely. The walls only slightly thickened towards the axis, but distally the thickening increases considerably. Calices are alveolitoid with projecting lip, usually 1 to 1·5 mm. diameter. Tabulae few and irregularly spaced. Mural pores indistinct in the specimens studied. Septal spines not seen.

Remarks. The specimens differ from Lecompte's diagnosis of the species (1939, p. 121) in only one respect, viz. in the absence of septal spines. They may be absent owing to the recrystallization and destruction of the elements, or they may not have developed in the specimens examined. Septal spines have not been recognized in the species by Smith (1945, p. 64), who noted that *T. polyforata*, while resembling species of *Striatopora*, is distinguished from these by the absence of septal spines.

Kropfitsch and Schouppé (1953, p. 95) excluded *Thamnopora dubia* (de Blainville) from *T. polyforata* (Schlotheim) as described by Smith (1945), because of differences in the fibrous structure of the corallite walls, and the branch diameters. Smith stated that



TEXT-FIG. 6. *Thamnopora polyforata* (Schlotheim). *a*, BU 18115, transverse section. *b*, BU 18114 longitudinal section. Both figured specimens from the Roadwater Limestone at Sandhill Farm. Both enlargements ×2·5.

under 'magnification the walls show fibrous structure, and fibres running at right angles to the wall, and also, although much less distinctly, a laminar structure parallel to the walls' (p. 64). Because of this laminar structure parallel to the walls, Kropfitsch and Schouppé (1953, p. 96) considered that Smith's *T. polyforata* should be included in the genus or subgenus *Pachypora* Lindstrom. This proposal is unsatisfactory for, while the type species of *Pachypora* has laminae parallel to the walls, it has no prominent fibrous structure at right angles to the wall as described in *T. polyforata* by Smith (see Lecompte 1936, p. 27, pls. 4, 5, for excellent figures of the type-species *P. lamellicornis* Lindstrom). Furthermore, Smith indicated that 'Schlotheim's type . . . which consists of a single branch is in a somewhat better state of preservation than Goldfuss's, which comprises several branches'. Differences in the state of preservation may, indeed, account for the presence of the faint laminar structure parallel to the wall in Schlotheim's material and the absence of the same structure in Goldfuss's specimen. Lecompte (1936, p. 57), in his study of the Goldfuss material, indicated a branch diameter not exceeding 6 mm., and later (1939, p. 121), in his diagnosis of *T. dubia*, 'Polypier branchu à rameaux délicats de 6 à 8 mm. de diamètre'. Kropfitsch and Schouppé have preferred the earlier interpretation of Lecompte, considering that the branch diameter is 6 mm., whereas Smith has indicated that the branches are typically about 7·5 mm. in diameter, in agreement with Lecompte's later viewpoint. Smith's inclusion of '*Favosites dubia* Edwards and Haime 1851' in his synonymy of *T. polyforata*, a species which was made a synonym of *T. boloniensis* by Lecompte (1939), is rightly questioned by Kropfitsch and Schouppé. Altogether there seems to be too little evidence assembled by Kropfitsch and Schouppé for separating *T. polyforata* and *T. dubia*, and they should be regarded as synonyms.

Occurrence. T. polyforata has been recorded from many localities in Europe, chiefly in Belgium and Germany, and a closely comparable form is reported from Australia. The species occurs in the Upper Givetian and Frasnian of the Dinant Basin (Lecompte 1939), in the Middle Devonian of Germany and Austria (Kropfitsch and Schouppé 1953), and the Givetian or Frasnian of Western Australia (Hill 1954).

Phylum BRACHIOPODA (ARTICULATA)
Superfamily SPIRIFERACEA Waagen 1883
Family SPIRIFERIDAE King 1846
Subfamily SPIRIFERINAE Schuchert 1913
Genus SPINOCYRTIA Fredericks 1916

Type species. Delthyris granulosa Conrad 1839.

Diagnosis. See Cooper (*in* Shimer and Shrock 1944, p. 323).

Spinocyrtia ascendens (Spriestersbach)

Plate 1, figs. 1–7

non 1842 *Spirifer mediotextus* Archiac and Verneuil, p. 370, pl. 35, figs. 9, 9*a–c*.
1871 *Spirifer mediotextus* var. Kayser, p. 573, pl. 11, fig. 1.
1900 *Spirifer mediotextus* Scupin, p. 21, pl. 2, figs. 4–6.
1935 *Spirifer ascendens* Spriestersbach, p. 498, pl. 45, figs. 1, 2.
1942 *Spirifer* (*Spinocyrtia*) *ascendens* Paeckelmann, p. 16, text-fig. 14; pl. 1, fig. 4.
? 1950 *Hysterolites mediotextus* Termier and Termier, p. 77, pl. 107, figs. 21–23; pl. 108, fig. 4; pl. 109, figs. 1, 2.
1959 *Spinocyrtia ascendens* Vandercammen, p. 29.

Description. Shell medium to large, unequally biconvex, spiriferoid, apsacline; cardinal extremities rounded; hinge-line straight, greatest width a little anterior to the hinge-line. Surface of shell lateral to fold and sinus with 13 to 18 costae (observations from 10 specimens); each costa high and rounded in the umbonal region, gradually becoming low, gently convex, and wider towards the anterior margin; furrows between costae rounded, deep and narrow in the umbonal region, becoming gently concave and wider near the anterior margin. Growth-lines of two types; prominent widely spaced, and numerous fine, closely spaced types, which are crossed by fine radiating microfila; tear-granules appear to be situated at the intersections of microfila and growth-lines.

Pedicle valve convex. Sinus broad, shallow, subangular; median depression marked near beak. Lateral slopes curved. Beak prominent and incurved. Area high, slightly concave, with fine transverse and longitudinal striations. Delthyrium open, a little higher than wide. Internal features unknown, except for the long divergent dental plates.

Brachial valve less convex than pedicle. Fold prominent, broad, low, not greatly elevated above level of the costae; faint median groove towards the beak. Lateral slopes gently convex. Umbonal region elevated only slightly above hinge-line. Beak inconspicuous. Area narrow; notothyrium wide; cardinal process low; dental sockets widely divergent, groove-like, as seen in one specimen.

Dimensions. Measurements were made from 19 reasonably complete specimens, 11 of the brachial valve, 8 of the pedicle valve. The following are the average measurements in mm. (the number of measurements made is given in brackets with each average value):

Length around margin of pedicle valve	29·0 (5)
Height of brachial valve	21·8 (10)
Height of area in pedicle valve	12·5 (7)
Thickness of pedicle valve	11·0 (3)
Thickness of brachial valve	5·9 (10)
Maximum width	31·7 (13)
Hinge width	29·5 (16)
Angle of sinus	30° (3)
Angle of fold	26° (9)

Remarks. A comprehensive description of the type species *Spinocyrtia granulosa* (Conrad) and related species from North America by Ehlers and Wright (1955) allows a much closer comparison between American and European forms than was hitherto possible. One of the diagnostic features of the genus is the presence of tiny tear-shaped granules, which many of the European forms ascribed to this genus seem to lack, or they have not been observed. Perhaps the poor state of preservation in many of the European forms explains the frequent absence of the micro-ornament. Latex impressions of an external mould of *Spinocyrtia ascendens* from west Somerset produced indubitable tear-shaped granules.

In a redescription of *Spinocyrtia mediotexta* (Archiac and Verneuil), Vandercammen (1959) considered the differences between the related forms, *S. subcuspidata* (Schnur) from the Upper Emsian, *S. geesensis* (R. and E. Richter) from the Couvinian, *S. ascendens* (Spriestersbach), *S. ascendens* var. *plicatula* Paeckelmann, and *S. mediotexta* from the Givetian. According to Vandercammen, the differenees between these forms are slight: *S. mediotexta* can be distinguished in having a slightly concave fold, and 21 to 29 costae per flank, although the specimens of *mediotexta* from Gerolstein have only 15 to 18 per flank; *S. ascendens* can be separated from its variety *plicatula*, which has a marked

EXPLANATION OF PLATE 1

All figured specimens are from the Oaktrow Sandstone at Oaktrow quarries (National Grid Ref. SS939402).

Figs. 1–7. *Spinocyrtia ascendens* (Spriestersbach). 1, BU 18126, ×1·5, ventral view of internal mould of pedicle valve showing sinus, costae on the lateral slopes, and long divergent dental plates. 2, BU 18126, ×1·5, lateral view of internal mould of pedicle valve showing strong convexity of valve, and the high, slightly concave area. 3, BU 18126, ×1·5, posterior view showing internal mould of area in the pedicle valve. 4, BU 18128, ×1·5, internal mould of brachial valve exhibiting fold and costae on the lateral slopes. 5, BU 18130, ×1·5, internal mould of the brachial valve of a small specimen. 6. BU 18127, ×7, detail of latex impression of external mould of the brachial valve showing a portion of the fold with micro-ornament of tear-granules which appear at the intersection between fine radiating microfila and growth-lines. 7, BU 18129, ×2, latex impression of external mould of the area of pedicle valve showing fine transverse and longitudinal striations.

Figs. 8–13. *Thomasaria gibbosa* Vandercammen. 8, BU 18132, ×3, ventral view of internal mould of pedicle valve showing weakly developed sinus and short divergent dental plates. 9, BU 18132, ×3, dorsal view of internal mould of brachial valve. 10, BU 18132, ×3, latex impression of external mould of brachial valve showing faint concentric growth-lines. 11, BU 18132, ×3, lateral view of internal mould of both valves. 12, BU 18134, ×3, ventral view of internal mould of pedicle valve. 13. BU 18133, ×3, ventral view of internal mould of pedicle valve of a large specimen showing projecting tongue-like anterior margin.

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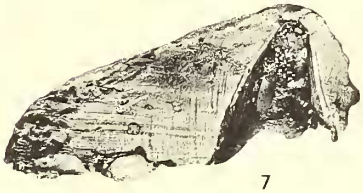

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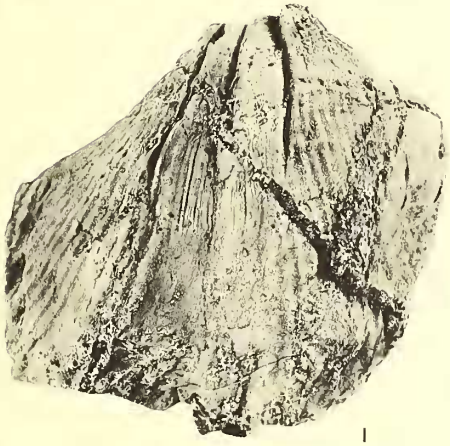

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WEBBY, Devonian brachiopods

median depression from the beak to the anterior margin on the fold; and only small differences separate *S. subcuspidata*, *S. geesensis*, and *S. ascendens*—12 to 14 costae per flank in *S. subcuspidata*, ±13 in *S. geesensis*, and 13 to 18 in *S. ascendens*.

Occurrence. This species is present in the Givetian of both the Eifel and the Bergisches Land, Germany. In west Somerset it is fairly common in the Harwood Beds and the Oaktrow Sandstone of the Avill Group. Some of the Belgian specimens formerly identified as *Spirifer mediotextus* probably belong to this species. A similar form is reported from Morocco.

Subfamily AMBOCOELIINAE George 1931
Genus THOMASARIA Stainbrook 1945

Type species. T. altimbona Stainbrook 1945.

Diagnosis. See Vandercammen (1956, p. 19).

Thomasaria gibbosa Vandercammen

Plate 1, figs. 8–13

1956 *Thomasaria gibbosa* Vandercammen, p. 19, text-figs. 12–19; pl. 1, figs. 28–44.

Description. Shell small, unequally biconvex, subcircular to pentagonal in outline; cardinal extremities rounded; wider than long, with the greatest width anterior to the hinge-line; area small, elevated and curved; catacline. Some specimens exhibit a weak fold and sinus towards the anterior margin; anterior commissure uniplicate. Fine concentric growth-lines present at widely spaced intervals.

Pedicle valve strongly convex; sinus weak, commencing as a shallow depression away from the beak, and widening to the anterior margin where it projects slightly as a rounded, tongue-like projection. Area small, concave, twice as wide as high. As the specimens are moulds, details of internal structures are lacking, except for the divergent dental plates.

Brachial valve less convex than pedicle valve. No fold observed. Umbonal region slightly elevated; internal mould of beak short, pointed, and slightly incurved; a shallow, narrow median groove extends across the incurved beak region. Two small, slit-like teeth sockets seen in one specimen.

Dimensions. Measurements in mm.

	BU 18132	*BU 18133*	*BU 18135*	*BU 18136*	*BU 18134*
Length around margin of pedicle valve	7·5	11·1	5·2	5·0	8·1
Height of brachial valve	6·3	—	4·5	4·0	—
Height of area in pedicle valve	1·0	1·8	—	1·0	1·5
Thickness of pedicle valve	2·8	3·6	2·3	1·6	2·7
Thickness of brachial valve	1·4	—	1·2	0·5	—
Maximum width	9·6	11·0	6·1	5·4	8·0
Hinge width	5·9	8·0	3·1	2·9	4·1

Remarks. The Oaktrow specimens are moulds, and while they do not show all the features given in the type description (Vandercammen 1956), they do exhibit all the diagnostic characters. Vandercammen noted that *Thomasaria gibbosa* differs from *T. parallela* Vandercammen in having strongly divergent dental plates.

Occurrence. In Belgium, *T. gibbosa* occurs as a rare species in a number of localities, ranging in age from Upper Givetian throughout the Frasnian. In the Brendon Hills, it is moderately abundant in the Oaktrow Sandstone.

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REFERENCES

ARCHIAC, A. d' and VERNEUIL, E. de. 1842. On the fossils of the Rhenish Provinces. *Trans. geol. Soc. Lond.* ser. 2, **6**, 303–410, pl. 25–38.

ASSERETO, R. 1962. Celenterati devonici del Monte Osternig (Alpi Carniche). *Riv. ital. Paleont.* **68** (1), 3–38, pl. 1–4.

BIRENHEIDE, R. 1961. Die *Acanthophyllum*-Arten (Rugosa) aus dem Richtschnitt Schönecken-Dingdorf und aus anderen Vorkommen in der Eifel. *Senck. leth.* **42**, (1–2), 77–146, pl. 1–7.

—— 1962. Die Typen der Sammlung Wedekind aus den Familien Cyathophyllidae und Stringophyllidae (Rugosa). Ibid. **43**, (2), 101–23, pl. 14.

БУЛЬВАНКЕР, Э. З. (BULVANKER, E. Z.). 1958. Девонские четырехлучевые кораллы окраин Кузнецкого бассейна. *Всесою. науч.-исследоват. геол. инст. ВСЕГЕИ*, 1–212, табл. 1–43. Ленинград.

CHAMPERNOWNE, A. 1884. On some Zaphrentoid corals from British Devonian beds. *Quart. J. geol. Soc. Lond.* **40**, 497–506, pl. 21–23.

COOPER, G. A. 1944. *In* SHIMER, H. W. and SHROCK, R. R. *Index Fossils of North America*, Phylum Brachiopoda, 277–365, pl. 105–43. New York.

EHLERS, G. M. and WRIGHT, J. D. 1955. The type species of *Spinocyrtia* Fredericks and new species of this brachiopod genus from Southwestern Ontario. *Contr. Mus. Geol. Univ. Mich.* **13** (1), 1–32, pl. 1–11.

ETHERIDGE, R. 1867. On the physical structure of West Somerset and North Devon, and on the palaeontological value of the Devonian fossils. *Quart. J. geol. Soc. Lond.* **23**, 568–698.

EVANS, J. W. 1922. The geological structure of the country round Combe Martin, North Devon. *Proc. Geol. Ass. Lond.* **33**, 201–34.

FRECH, F. 1886. Die Cyathophylliden und Zaphrentiden des deutschen Mitteldevon. *Paläont. Abh.* **3** (3), 115–234, pl. 13–20.

GOLDFUSS, G. A. 1826–33. *Petrefacta Germaniae* I: 1–76, pl. 1–25 (1826); 77–164, pl. 26–50 (1829); 165–240, pl. 51–71 (1831); 241–52 (1833). Düsseldorf.

HALLER, W. 1935. Einige biostratigraphische Untersuchungen in der Rohrer Mulde unter besonderer Berücksichtigung der Keriophyllen. *Jb. preuss. geol. Landesanst.* **56**, 590–632, pl. 32–43.

HICKS, H. 1897. On the Morte Slates, and associated beds in North Devon and West Somerset, Part II. *Quart. J. geol. Soc. Lond.* **53**, 438–62, pl. 31–35.

HILL, D. 1954. Coral faunas from the Silurian of New South Wales and Devonian of Western Australia. *Bull. Bur. Min. Resour. Aust.* **23**, 1–51, pl. 1–4.

—— 1956. *In* MOORE, R. C., Ed. *Treatise on Invertebrate Paleontology, Part F. Coelenterata*, Rugosa, F233–323. Geol. Soc. Amer. and Univ. Kansas Press.

HOLWILL, F. J. W. 1961. The limestones of the Ilfracombe Beds. *Abstr. Proc. 4th Conf. Geol. Geomorph. S.W. England, R. geol. Soc. Cornwall*, 12, 13.

—— 1963. The succession of limestones within the Ilfracombe Beds (Devonian) of North Devon. *Proc. Geol. Ass. Lond.* **73**, 281–93.

ЯКОВЛЕВ, Н. Н. (JAKOVLEV, N. N.). 1947. Класс Anthozoa. Атлас руководящих форм ископаемых фаун СССР, III; Девонская система, 42–55. Москва-Ленинград.